Decision Rationale

Total Maximum Daily Load for
the Aquatic Life Use Impairment on Quail Run

I. Introduction

The Clean Water Act (CWA) requires a Total Maximum Daily Load (TMDL) be developed for those water bodies identified as impaired by a state where technology-based and other controls will not provide for attainment of water quality standards. A TMDL is a determination of the amount of a pollutant from point, nonpoint, and natural background sources, including a margin of safety (MOS), that may be discharged to a water quality-limited water body.

This document will set forth the Environmental Protection Agency's (EPA's) rationale for approving the Benthic TMDL for the Quail Run watershed. EPA's rationale is based on the determination that the TMDL meets the following eight regulatory conditions pursuant to 40 CFR §130.

1) The TMDL is designed to implement applicable water quality standards.
2) The TMDL includes a total allowable load as well as individual wasteload allocations (WLA) and load allocations (LA).
3) The TMDL considers the impacts of background pollutant contributions.
4) The TMDL considers critical environmental conditions.
5) The TMDL considers seasonal environmental variations.
6) The TMDL includes a MOS.
7) There is reasonable assurance that the TMDL can be met.
8) The TMDL has been subject to public participation.

II. Background

The 3,513 acre Quail Run Watershed is located in Rockingham County. Quail Run is a tributary to Boones Run which flows into the South Fork of the Shenandoah River. Land use in the watershed is evenly distributed between forest (42%) and agricultural (40%) lands. High and low intensity developments make up the remaining 18% of the watershed.

In response to Section 303(d) of the CWA, the Virginia Department of Environmental Quality (VADEQ) listed 5.07 miles of Quail Run on Virginia's 1998 Section 303(d) list as being unable to attain the general standard for aquatic life use. The failure to attain the general standard for aquatic life use was determined through biological assessments of the benthic macroinvertebrate community. This decision rationale will address the TMDL for the impairment of the aquatic life use.

Virginia's 305(b)/303(d) guidance states that support of the aquatic life beneficial use is

determined by the assessment of conventional pollutants (dissolved oxygen, pH, and temperature); toxic pollutants in the water column, fish tissue, and sediments; and biological evaluation of benthic community data.[1] Therefore, a biological assessment of the benthic community can be used to determine a stream's compliance with the state's general standard for aquatic life use. Virginia uses EPA's Rapid Bioassessment Protocol (RBPII) to determine status of a stream's benthic macroinvertebrate community.[2] This approach evaluates the benthic macroinvertebrate community between a monitoring site and its reference station. Measurements of the benthic community, called metrics, are used to identify differences between monitored and reference stations.[3]

Reference stations are established on streams which are minimally impacted by humans and have a healthy benthic community. Streams that are classified as moderately or severely impaired after an RBPII evaluation are classified as impaired and are placed on the Section 303(d) list of impaired waters. Since 1996 Quail Run was has been evaluated as containing a moderately to severely impacted benthic community.

The RBPII assesses the health of the macroinvertebrate community of a stream. The analysis informs the biologist if the stream's benthic community is impaired. However, it will not inform the biologist as to what is causing the degradation of the benthic community. Additional analysis is required to determine the pollutants which are causing the impairment. TMDL development requires the identification of impairment causes and the establishment of numeric endpoints that will allow for the attainment of designated uses and water quality criteria.[4] In Virginia's 1998 Section 303(d) List, Massanutten Sewage Treatment Plant (STP) was identified as the source of the benthic impairment. It was believed that several discharge violations associated with this facility were permitting the release of ammonia and chlorine at levels which the stream could not assimilate and maintain a healthy aquatic system. As part of the TMDL development process DEQ analyzed other possible sources of this impairment.

DEQ treated ambient water quality monitoring (AWQM) station QAL005.29 and biological monitoring station QAL005.09 located just upstream of the Massanutten STP as representing reference conditions. Reference conditions mark the water quality conditions necessary to support a healthy aquatic benthic macro invertebrate population. QAL005.09 was evaluated as moderately impaired

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[1]VADEQ. 1997. 1998 Water Quality Assessment Guidance for 305(b) Water Quality Report and 303(d) TMDL Priority List Report. Richmond, VA.

[2]Tetra Tech 2002. Total Maximum Daily Load (TMDL) Development for Blacks Run and Cooks Creek. Fairfax, Virginia.

[3]Ibid 2

[4]Ibid 2

from October of 1998 through May of 2000. It is believed that this was due to extreme low flows exhibited at the site during that period and leakage from a nearby treatment lagoon. However, the site rebounded in the October 2000 and 2001 analysis and therefore is believed to support a healthy benthic population. The impaired sampling locations (QAL004.30 and QAL005.04) are located downstream of the STP and have consistently been evaluated as having a poorer benthic communities.

Nutrient, turbidity, dissolved oxygen, pH, alkalinity, chloride and organic matter levels from the impacted segment where compared to concentrations found at the reference location in order to determine the pollutants of concern. Total Suspended Solids (TSS) were evaluated in both the impacted (QAL004.30) and reference (QAL005.29) locations. The TSS levels found at the two locations indicated that this was not a cause of impairment. Temperature and alkalinity measurements were found to be very similar between the two locations as well. Dissolved oxygen (DO) data collected at the two AWQM stations indicated that DO levels were above the appropriate numeric criteria. Chlorides, organic matter, and nutrients were consistently higher in the impacted segment.

In addition to the AWQM DO data, DEQ conducted a diel DO analysis on August 15 & 16 and September 17&18 of 2002. Diel DO was measured 4,000 and 1,300 feet downstream of the STP discharge in August and 100 feet upstream and 500 and 1,300 feet downstream of the STP discharge in September. The summer season is when one would expect the lowest DO concentrations to be found due to a combination of high water temperatures (lower solubility of oxygen) and low flows. The flows encountered during the sampling period were less than the 7-day duration, 10-year return flow (7Q10) of 0.45 cfs. DO concentrations and temperatures were evaluated over five-minute intervals for a 24-hour period each day. In August the DO concentrations at the sampling location 1,300 feet downstream dipped to 1 mg/L which is below the 4.0 mg/L instantaneous criteria. The concentrations did not dip below the criteria at the location 4,000 feet downstream. In September the DO concentrations at the sampling locations 100 feet upstream and 500 feet downstream violated the criteria. It is believed that algal growth exasperated the DO problems observed during both sampling events. The increased algal growth may have been caused by the construction activities occurring at the STP which removed significant amounts of vegetative cover. Therefore, these organisms would have been exposed to greater levels of sunshine thereby increasing the opportunity for growth and development. It is believed that low DO is not causing or contributing to the problem at the downstream monitoring site since the low DO levels were alleviated upstream of QAL004.30. It is also believed that the DO concentrations will rebound after construction when the riparian zone will be vegetated and therefore shade will be provided. This will also reduce the algal growth observed on site.

Toxics were identified as the cause of impairment during the 1998 Section 303(d) Listing. The TMDL study identified four possible sources of toxic contamination to Quail Run. Three of these sources are associated with the STP; ammonia, chlorine, and chlorination by-products. The fourth source identified was pesticides associated with surface runoff. Agriculture was eliminated as a source of ammonia because there is a negligible amount of agriculture and there was no link found between

ammonia violations and rainfall. According to the TMDL study, "there was little precipitation on the days of violation and in general low or average precipitation during the previous two week period.".[5] Nonpoint sources of ammonia can also be ruled out as a problem since there were no violations reported upstream of the STP.

Chlorine and chlorination by-products were viewed as a possible source of impairment. "At the Massanutten STP, breakpoint chlorination was practiced during periods of the year when the nitrification reactor was not operating optimally to reduce ammonia discharges. This required chlorine application rates that increased the potential for formation of toxic chlorine by-products. ... circumstantial evidence indicates that ammonia and chlorination by-products are the likely sources of the historical benthic impairment on Quail Run.".[6] Normal chlorination uses 7 to 10 mg/L of chlorine for disinfection while breakpoint chlorination uses concentrations in excess of 100 mg/L. Toxicity sampling documented that the Lesser Water Flea was impacted by breakpoint chlorination. Based on the above discussion, the TMDL was developed for ammonia and chlorine.

Table 1 - Summarizes the Specific Elements of the TMDLs.

Segment	Parameter	TMDL (kg/yr)	WLA (kg/yr)	LA (kg/yr)	MOS (kg/yr)
Quail Run	Ammonia	7,857	7,185	279	393
	Total Residual Chlorine	27.63	27.63	0	Implicit

The United States Fish and Wildlife Service has been provided with copy of this TMDL.

[5]VADEQ 2003, Benthic TMDL for Quail Run, Rockingham County, Virginia.

[6]Ibid 5

III. Discussion of Regulatory Conditions

EPA finds that Virginia has provided sufficient information to meet all of the eight basic requirements for establishing an aquatic life use (benthic) impairment TMDL for Quail Run. EPA is therefore approving this TMDL. Our approval is outlined according to the regulatory requirements listed below.

1) The TMDL is designed to meet the applicable water quality standards.

The monitored sites were listed as impaired due to a degradation of the benthic macroinvertebrate community. As mentioned above, benthic assessments inform the biologist of an impairment, but they are unable to identify a stressor. Therefore, a reference watershed approach was used to identify the stressors to these streams. Virginia has indicated that excessive levels of toxics (ammonia and chlorine) have caused the degradation of the benthic community on Quail Run. The Commonwealth does have numeric criteria for these pollutants. Past violations of the ammonia criteria indicated that this pollutant was at levels of concern.

The QUAL2E model was used to determine the allowable loading rate to Quail Run. The QUAL2E model was established and developed in association with the VPDES permit for Massnutten STP. As stated in the TMDL, The Massnutten STP discharge represents almost the entire stream flow "The 7Q10 flow at the STP is estimted to be 0.045 cfs. With a current permitted discharge of 1.16 cfs, the STP effluent constitutes almost the entire streamflow during low flow conditions."[7]

2) The TMDL includes a total allowable load as well as individual WLAs and LAs.

Total Allowable Loads

Virginia indicates that the total allowable loading is the sum of the loads allocated to land based precipitation driven nonpoint source areas (forest and agricultural land segments), point sources, and the MOS.

Wasteload Allocations

Virginia has stated that there is one point source, Massnutten STP, discharging ammonia and chlorine. The WLA for ammonia can be determined by multiplying the allowable concentration (2.6 mg/L) by the permitted flow of 2,000,000 gallons per day by the number of days in a year (365). The WLA for chlorine can be determined using the same procedure for a concentration of 0.01 mg/L. The

[7] Ibid 5

WLAs are illustrated on Table 2.

EPA regulations require that an approvable TMDL include individual WLAs for each point source. According to 40 CFR 122.44(d)(1)(vii)(B), "Effluent limits developed to protect a narrative water quality criterion, a numeric water quality criterion, or both, are consistent with assumptions and requirements of any available WLA for the discharge prepared by the state and approved by EPA pursuant to 40 CFR 130.7." Furthermore, EPA has authority to object to the issuance of any National Pollutant Discharge Elimination System (NPDES) permit that is inconsistent with the WLAs established for that point source.

Table 2 - WLAs for Quail Run TMDL

Stream	Facility	Permit Number	Allocated Load Ammonia (kg/yr)	Allocated Load Chlorine (kg/yr)
Quail Run	Massnutten STP	VA0024732	7,185	27.63

Load Allocations

According to Federal regulations at 40 CFR 130.2(g), LAs are best estimates of the loading, which may range from reasonably accurate estimates to gross allotments, depending on the availability of data and appropriate techniques for predicting loading. Wherever possible, natural and nonpoint source loads should be distinguished. A load allocation was provided for additional sources of ammonia which would include agricultural and other land based sources. These sources are negligible when compared to the ammonia load generated by the STP. A load allocation was not provided for chlorine as there were no other sources of this pollutant.

The nonpoint source ammonia load was estimated from the AWQM data collected at QAL005.29. Analysis of the twenty-two samples collected form July of 1997 through June of 2001 revealed that ammonia concentrations were either at or below the detection limit of 0.04 mg/L. Therefore, an ammonia concentration of 0.04 mg/L was used to quantify the NPS load. The concentration was converted to an annual load by multiplying the concentration by the mean annual discharge. The mean annual discharge was estimated on data collected from White Oak Run a similar watershed in the region.

3) The TMDL considers the impacts of background pollution.

Background pollution was not considered for chlorine since there were no background sources. Background loading was considered for ammonia. In determining the LA for Quail Run VADEQ used AWQM data which included background sources of this pollutant.

4) The TMDL considers critical environmental conditions.

According to the EPA regulation 40 CFR 130.7 (c)(1), TMDLs are required to take into account critical conditions for stream flow, loading, and water quality parameters. The intent of this requirement is to ensure that the water quality of the Quail Watershed is protected during times when it is most vulnerable.

Critical conditions are important because they describe the factors that combine to cause a violation of water quality standards and will help in identifying the actions that may have to be undertaken to meet water quality standards.[8] Critical conditions are a combination of environmental factors (e.g., flow, temperature, etc.), which have an acceptably low frequency of occurrence. In specifying critical conditions in the waterbody, an attempt is made to use a reasonable "worst-case" scenario condition. For example, stream analysis often uses a low-flow (7Q10) design condition because the ability of the waterbody to assimilate pollutants without exhibiting adverse impacts is at a minimum. This was done for Quail Run, since the Massnutten STP represents such a large portion of the stream flow and its impacts are strongest under low flow conditions.

5) The TMDLs consider seasonal environmental variations.

Seasonal variations involve changes in stream flow as a result of hydrologic and climatological patterns. In the continental United States, seasonally high flows normally occur in early spring from snow melt and spring rain, while seasonally low flows typically occur during the warmer summer and early fall drought periods. The TMDL focused on low flow conditions because that is when the STP's impacts are greatest. It was felt that if criteria could be met during these period it would be attained during all other flows.

6) The TMDLs include a MOS.

This requirement is intended to add a level of safety to the modeling process to account for any uncertainty. The MOS may be implicit, built into the modeling process by using conservative modeling assumptions, or explicit, taken as a percentage of the WLA, LA, or TMDL.

Virginia used an implicit and explicit MOS for the ammonia TMDL by estimating the ammonia concentration upstream of the Massnutten STP at 4.0 mg/L, which is greater than the observed data indicated, and reserving 5% of the total load for the MOS. An implicit MOS was used for the chlorine TMDL since the facility will only be discharging chlorine at 0.01 mg/L under emergency conditions.

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[8]EPA memorandum regarding EPA Actions to Support High Quality TMDLs from Robert H. Wayland III, Director, Office of Wetlands, Oceans, and Watersheds to the Regional Management Division Directors, August 9, 1999.

7) There is a reasonable assurance that the TMDL can be met.

EPA requires that there be a reasonable assurance that the TMDL can be implemented. The WLA will be implemented through the NPDES permit process. According to 40 CFR 122.44(d)(1)(vii)(B), the effluent limitations for an NPDES permit must be consistent with the assumptions and requirements of any available WLA for the discharge prepared by the state and approved by EPA. Furthermore, EPA has authority to object to issuance of an NPDES permit that is inconsistent with WLAs established for that point source. The TMDL did not require other forms of control.

8) The TMDLs have been subject to public participation.

To inform the stakeholders of the TMDL process, a single public meeting was public noticed on January 27, 2003 and held on February 10, 2003 at the Spotswood High School in Penn Laird, Virginia.[9] Copies of the TMDL report and presentation materials were distributed in the meeting which was attended by 18 people. The comment period concluded on March 12, 2003. DEQ submitted copies of all written comments with the TMDL.

[9] Ibid 5